PARTICIPATORY RESEARCH: WILL THE KOEL HATCH THE CROW'S EGGS?

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"To mobilize the masses does not mean to issue them with shovels and instructions; it means to fire them with enthusiasm, to release their initiatives and to tap their wisdom."

Joshua S. Horn
Away With All Pests: An English Surgeon in People's China, 1969, pg. 97.

This paper describes an experiment in participatory research for sustainable development. The experiment relies upon certain crucial underlying assumptions. The traditional models of on-station development of technology and its transmission to farmers are no longer feasible, since high ecological variability demands niche-specific solutions. Local solutions developed by farmers themselves need to be identified and their scientific bases understood. The value-added scientific principles have to be shared back with farmers, who would then be able to develop technologies through their own research and experimentation. Thus transferring `science' and not just technology (Gupta, 1989a & 1994b). Supporting and developing such experimentation is an important task for scientists and outsiders. Perhaps the most crucial challenge is for scientists to realize that how they can participate in people's programs rather than asking how people can participate in formal outside initiatives.

The paper is organized in four parts. The introductory part deals with the context of participatory research and provides a brief description of the *Honey Bee* network which is based on the principles outlined above. The second part describes the process of participation and the various methods used by the network for participating in people's research programs. The third part presents a contingent framework of participatory research. The final section deals with some reflections on learning from women innovators and stresses the importance of identifying and transferring science in order to enable farmers to develop their own technologies.

Context of Participatory Research and the Honey Bee Network

It is well known that the crow incubates and hatches the eggs of the koel (a species of cuckoo). But will the koel hatch the crow's eggs? Farmers have tried out scientists' ideas in the past. Will scientists now be willing to hatch the ideas of farmers? This is the direction in which participatory research will have to progress in the future. It implies a patient, persistent, ethical and accountable learning route to the development and diffusion of technologies. The need to find universally-applicable and quick solutions, often encouraged by the power of aid in the form of "participatory" methods like RRA/PRA, unfortunately militates against such an approach. The fact that hitherto insensitive and indifferent bureaucracies the world over find these methods legitimate, should itself have made everybody skeptical about them. We will not dwell further on this issue.

The participation of people in research programs aimed at developing sustainable technologies is considered inevitable today. This change in outlook, within less than three decades of the onset of the green revolution, is a result of the increasingly complex interactions between local socioecological and institutional conditions, and externally-induced technological change. In other words, the challenge technology designers face today is how to move away from delivering fully-tailored cloth towards supplying semi-stitched cloth which may be tailored by users themselves, keeping local specifications in mind. This requires both an understanding of the tailoring process on the part of the people, and an understanding of local preferences, criteria and specifications on the part of researchers.

Another reason for seeking participation is that it provides opportunities to scientists to recalibrate their scales of measurement and co-ordinates of perception. Perhaps what is more important is developing in scientists the ability to learn how to participate in the plans, programs, experiments and missions of farmers themselves (Gupta 1980, 1987b, 1995d). Ashby *et al*. (1987) had rightly criticized the excessive emphasis on the so-called diagnostic research methods that treated farmers as objects of investigation and in the process lost the farmers' voice. She emphasized that participatory research should involve farmers as co-investigators and researchers, and demonstrated, through farmer-managed trials, creative ways of understanding farmers' criteria for selecting varieties. Gupta (1987d), while describing the dynamics of homestead utilization by women, provided examples of the criteria used by poor women in the management of sweet potato seedlings, that had never formed a part of formal scientific research. There are many other examples, including the excellent research of Richards (1985, 1987), that demonstrate the need for scientists to participate in farmers' own research programs.

However, any process of collaborative learning can be meaningful and mutually enjoyable only when the classificatory schemes or taxonomies used by the partners are matched. It is not necessary to synthesize these taxonomies, but it is essential to understand the various vectors on which each knowledge system organizes information and generates patterns of knowledge. Does it matter in a dialogue between farmers and scientists in Peru whether the potato is distinguished by its local name, *Puka suytu*, or only by its Latin name, *Solanum tuberosum* (Vasquez 1996)? It does not when two classificatory schemes are mere tools to highlight the strengths of the knowledge systems on which they are based. But when one system's superiority is asserted, or when scientists use scientific language to mask their inability to understand the richness of the vernacular, there is a problem.

A second aspect of matching taxonomies is the need for formal science to realize that an indigenous taxonomy would be extremely rich when the variance in any phenomenon critical for the survival of that community is high. The community breaks down the phenomenon into a larger number of discrete categories, and characterizes each category by a different name. Thus, for instance, Eskimos have a large number of words for snow, and fisherfolk many names for varieties of waves. Each category symbolizes not only a pattern but also a theory underlying the classification and interrelationship of different categories.

Collaborative learning is not limited to just matching taxonomies. It raises the fundamental issue of the relevance of research. Scientists are "futurists", in the sense that they have the potential to shape the future (Latour 1983; Gupta 1987d). But by associating themselves only with particular user groups (for instance, better endowed farmers) or by following particular notions of "usefulness", issues concerning disadvantaged farmers may be pushed to the periphery. The question, therefore, is how can people affected by a research program influence the agenda and at what stage of the research. The concern for drawing upon people's knowledge while developing a research agenda is not new in the Indian context. In 1967, Dr.Y.P.Singh guided the first two postgraduate theses on indigenous knowledge. But the third had to wait till 1979 (Verma & Singh, 1969; Nand & Kumar, 1980). The need for ensuring relevance through building linkages between formal and informal research and development systems has been stressed by Biggs (1984) and many others including Chambers, Richards, Gupta, Ashby, Warren, Juma and Atte.

Finally, collaborative learning also implies that language does not become a barrier. Most research is published in English, with the result that local people do not get a chance to read and criticize. Sharing in the local language, at all stages of research, is an ethical dimension of participatory research as well as a means to achieve efficiency. That is what became the point of departure in the Honey Bee network.

The Honey Bee Network

The purpose of the *Honey Bee* network is to bring together people engaged in eco-restoration and reconstruction of knowledge about precious ecological, technological, and institutional systems. The network specifically aims at identifying innovative individuals or groups who have tried to overcome technological and institutional constraints with the help of their own imagination and effort. The innovations developed by such people are based on low external inputs, are ecofriendly and have the potential to improve productivity at a low cost. The values that underpin a network of such innovative people -- the spirit of excellence, critical peer group appraisal, competitiveness and entrepreneurship for self-reliant development -- would generate pressure for sustainable development that will counter the externally-driven and patronizing initiatives of the "people-as-victims" developmental paradigm.

The *Honey Bee* network brings out a newsletter of the same name in six languages in India (English, Hindi, Gujarati, Kannada, Tamil and Telugu) and in Zonkha in Bhutan. Offers have been received from Nepal, Sri Lanka, Colombia, Uganda, Paraguay and Mali for local language versions. The network is headquartered at SRISTI (Society for Research and Initiatives for Sustainable Technologies and Institutions, c/o Prof Anil K. Gupta, Indian Institute of Management, Ahmedabad), an autonomous global NGO, and extends to 75 countries at present.

Honey Bee insists that two principles are followed without fail: (a) whatever we learn from people must be shared with them in their language, and (ii) every innovation must be sourced to individuals/ communities with names and addresses in order to protect the intellectual property rights of the people. Such a process of learning and sharing implies that one has to realize that the boundaries between formal and informal knowledge systems may often be false. The informal system may have formal rules waiting to be discovered. The formal system may have informal beliefs or conjectures that may provide an impetus for further inquiry.

More than five thousand innovative practices, mainly from dry regions, have been documented over the last six years. Disadvantaged people may lack financial and economic resources, but they are definitely rich in knowledge. The label 'resource-poor farmer' is one of the most inappropriate and demeaning contributions from the West. At the same time, we realize that the market may not be pricing people's knowledge properly today. For instance, out of 120 plant-derived drugs, 74 per cent are used for the same purpose for which the native people discovered their use (Farnsworth 1988), implying that the basic research to link cause and effect had been done successfully by the people in a large number of cases. Modern science and technology can help by improving the efficiency of the extraction of the active ingredients or by synthesizing analogs (Gupta 1991a).

A second feature of this large collection is that people's knowledge systems need not always be considered informal just because the rules of the formal system fail to explain innovations in another system. The hazards of pesticide residues and their adverse effects on the human and ecological systems are well known. In the second issue of *Honey Bee*, out of the 94 practices reported, 34 dealt with indigenous low-external input plant protection methods. Some of these practices could extend the frontiers of science. For instance, some farmers cut 30 to 40 days-old sorghum plants or *Calotropis* plants and put these in irrigation channels in order to control or minimize termite attacks in light dry soils. Perhaps the hydrocyanide and other toxic elements in sorghum and Calotropis were responsible for the effect.

It is possible that private corporations may not have much interest in the development and diffusion of such alternatives which pass control of knowledge into the hands of people. However, an informed, educated and experimenting client always spurs better market innovations as is evident from the experience of the computer industry. Therefore, we do not see a contradiction between the knowledge systems of people and the evolution of market rules to strengthen and build upon them. However, such market model would have to be highly decentralized, competitive, open and participatory. *Honey Bee*, in that sense, is an effort to mold markets for ideas and innovations, but in favor of the sustainable development of high risk environments.

Of course no long-term change can be achieved if the local children do not develop values and a worldview consonant with the philosophy of sustainable development. Therefore, members of the network have also involved themselves in educational activities like holding biodiversity contests for school children. At another level, sustained change would demand a much higher scale of networking. The concept of Knowledge Centres/ Networks (Gupta 1995) was developed as a model suitable for the multilevel, multinodal and multichannel networking of individuals and institutions involved in sustainable development.

How do we Learn from People?

As stated earlier, the *Honey Bee* approach uses local solutions, developed by the people themselves in spite of technological and institutional constraints, as the basis for participation. Such a solution-augmenting strategy requires not just searching for local problem solvers, but also understanding their heuristics. The *Honey Bee* network has emphasized the role of innovative individuals far more than that of creative communities, not because the latter is less important but because the former has received much less attention in most Southern countries. The culture of compliance and conformity has also made many community structures less tolerant of local dissent, even if the latter is constructive. It is not surprising, therefore, to find that the innovations of a particular farmer are often not known even to his neighbors.

The methods that have been tried to identify and record innovations are listed below:

- survey of innovations (through students and innovators);
- competitions: (a) students (b) Government Officials;
- biodiversity contests;
- fairs and festivals;
- workshops;
- dissertations produced by students;
- participatory Institution-building initiatives;
- scanning of old literature.

Survey of Innovations

Survey through students. Students of undergraduate and postgraduate courses in agriculture and rural development are trained during their summer vacations in identifying innovations. The training is very simple. The students are asked to narrate some of their own experiences which they found interesting, intriguing and inspiring. By underlining the ones that we find counter intuitive or less obvious, we convey what we are looking for. Since we communicate our message through metaphors and the students' own examples, communication becomes very efficient. The students then go to the villages, identify innovators and record their experiences. They also collect addresses of a few farmers who either know about the innovator and/or have fields adjoining the fields of innovative farmer. We write letters to these contacts later to have a first round of confirmation. Later, each practice is revisited by another student/field investigator to avoid any error in the process.

Survey through innovators. This approach has been used to identify innovative artisans, through a process similar to "snowballing". In some cases, the innovators themselves have traveled to look for others of their kind. This process has been very rewarding in identifying innovations in farm implements and soil and water conservation.

Competitions for "Innovation Scouts"

Competitions have been organized in two Indian states (Gujarat and Rajasthan) among students of agricultural colleges and grassroots-level government functionaries. Workshops were first organized to provide some background about the prior research and to illustrate many of the innovations that had been identified by village level workers. No reference was made to any of the so-called "rapid" methods for the simple reason that the ability to scout around for innovators depended far more on one's framework of understanding rural creativity than on any particular method. The entries sent in by the participants were evaluated and the winners awarded prizes. The innovators were also honored. One positive impact of such honoring has been the increase in the esteem that such innovators now command in their own villages.

Biodiversity Contest: Identifying 'Little Eco-Geniuses'

Biodiversity contests were organized among school children, and in some cases, out-of-school children and adults. The aim of these contests is to identify the ecological knowledge of children in order to recognize alternative knowledge systems in dry and forest areas. Children are asked to bring samples of plants they know about, on an appointed day. They are quizzed about the uses of the plants, the plants they know about but did not find, and other nature-related aspects. The first contest was organized in Madurai, India, by SEVA. Similar contests were organized in Kerala, Uttar Pradesh and Gujarat in India and in Vietnam and Bhutan. What was most remarkable about these contests was the fact that young children from very disadvantaged backgrounds showed an extraordinary ability to inventorize biodiversity and its local uses. Mahadev K. Sodha of Tadav village in Gujarat, 12 years of age, listed as many as 305 plants. Ankita Patel, a 11-year old girl of Valawada village identified 165 plants. Several lessons have been learned from these competitions, but one of them needs to be specially highlighted (Vijay Sherry Chand, Shukla & Gupta 1996, Gupta 1993, Gupta 1994a).

In one of the villages, Virampur, Karimbhai, a potter by profession but knowledgeable about local herbs, was invited to give away the prizes. After the function, we offered him some utensils as a token gift. To our surprise, he refused to accept the gift. He was willing to sell his pots. But in his role as a biodiversity expert, he would not accept any payment because he had never charged for his healing services. He is an extremely poor person and had to withdraw his elder son from school in order to manage his business.

Some of the other lessons are listed below:

- The ecological ethics of some of the poorest people were far stronger than one would assume. However, one cannot keep people poor in order to conserve diversity or the ecological ethics. It should be possible to maintain ethics without deprivation.
- The sacred dimension of one's belief system is compatible with the secular goals of the innovators. It is this blended culture which has to guide the spirit of enquiry of young minds.
- Little children have sometimes shown a far greater spirit of participation than adults. For instance, when a 12-year handicapped, out-of-school girl brought a single leaf as an entry it became obvious that winning a race certainly was not uppermost in her mind. How do we sustain this spirit when children grow up?
- Older boys seem to know much more about biodiversity than girls. Perhaps the additional household responsibilities of older girls restrict their biodiversity-related pursuits.
- Children from the so-called backward castes seem to know more about plants. Children from other castes obviously spend less time grazing animals or collecting forest produce.
- Children less than 12 years old have already traveled half the intellectual distance covered by the most knowledgeable adult in the community. The tragedy is that the formal education system does not offer opportunities to such children for furthering their skills in nature-related fields. Unless they learn ‘A for apple, B for Boy, C for Cat’, there is very little future for these children.
- Ironically, high biodiversity areas also show high rates of drop out from primary schools. Such areas are also high in poverty and the migration of males. The proportion of female-headed or managed households, consequently, is high. If we generate incentives which accrue only to those who are educated, or are male, or do not migrate, the poor may be left out.
- In one of the contests held in Kerala, children brought not just the lists of plants but also the seedlings. The school administration decided to give some of the seedlings as prizes and living mementos to the participants. The result was that shuffling of the local biodiversity took place. This is an experiment which has enormous potential to promote a people to people exchange of knowledge as well as diversity.
- In a recent modification, ecological indicators were collected through such contests. More than sixty indicators related to prediction of rainfall and other climatic parameters, disease and pest attacks, fertility of soil, performance of animals and crops, were identified. Many of these indicators would have to be validated through systematic observation, cross-cultural testing and scientific appraisal. What is important is that many of these indicators embody wisdom encoded

in the form of easy-to-interpret signals. This knowledge can blend very well with scientific knowledge.

Fairs and Festivals: Message to the Masses

We had not used the various religious and cultural fairs and festivals organized in different parts of the country to communicate the *Honey Bee* message till December 1995, when we set up a stall in a fair meant for trading donkeys, camels and bullocks. Many farmers visited the stall and purchased copies of *Lok Sarvani* (Gujarati version of *Honey Bee*). The stall also had a computer for demonstrating the database on innovations in the local language. Farmers searched the database for solutions to their problems. They also offered solutions which they knew about but did not find in the database.

In another fair organized in Junagadh, we displayed an innovative bullock cart developed by Mr. Amrutbhai Agrawat, an artisan. As many as 400 farmers showed interest in buying the bullock cart and registered their names for getting further information. Recently an agricultural university placed the first order for the cart.

Lateral Learning Workshops

Participatory learning through peer group interactions. We have been organizing workshops for innovative artisans, farmers and local healers. Scientists also usually attend. Before the workshop, reports on the innovations are circulated to the participants. During the workshop, innovators articulate the processes they followed and their difficulties. Other participants offer critical comments, alternatives or variations known to them. In a recent workshop of traditional veterinary healers, the participants themselves developed an agenda for conserving the medicinal plants they used.

Traveling seminar. Given the critical importance of farm implements in rainfed regions, we organized a workshop of blacksmiths and carpenters. Since most artisans do not make drawings of their implements, it is difficult for a lay person to understand the uniqueness of an innovation. We realized that there was no escape from traveling together to the work places of the artisans. Thus was born the idea of traveling seminar. The concept was used earlier by Jock Anderson in 1968-69 as part of his institution building efforts in the wheat breeding program in Bangladesh as a part of CIMMYT support to the Bangladesh Agricultural Research Institute (Gupta,1985a).

Dissertations Produced by Students

In an on-going experiment with the Mahila Gram Vidyapith, Nardipur, Gujarat, under-graduate students of dairy science have been writing dissertations on technological and institutional issues concerning indigenous veterinary knowledge. Different subjects like indigenous animal breeds, selection criteria, veterinary healers, institutions for the maintenance of pastures, breeding bulls, sharing animals and indigenous dairy products have been studied.

Participatory Institution Building

In most of the natural resource management research programs involving group action, one of the most obvious weaknesses is the lack of attention to institution building. Technological choices in the absence of institutional anchors may not be sustainable, particularly if they require periodic renewal and reaffirmation by the group. We have tried several approaches to institution building over the last six years:

- investing in local leaders;
- legitimization of local experts as gatekeepers for external resources;
- stakeholder involvement in the network building process;
- embedding new ideas in existing institutions;
- establishing (experimenters' network).

The last approach is the one which appears to be the most promising. One of the most controversial aspects of institution building is the definition of the boundaries of the group or collective. It has often been assumed, almost axiomatically, that the local village boundaries are the most suitable. However, an appreciative peer group is very important for generating, criticizing, nurturing and sustaining creativity and the long-term vision. It is usually difficult to find a critical mass of such experimenters in one village. A network like the *shodh sankal* provides the pulverization that any soil needs in order to make sowing possible. It also provides the optimal resistance to an idea as well as the critical appreciation for it. The meetings of this network are held in different villages.

Scanning of Old Literature

A sense of history is extremely important when blending different knowledge systems and ideas. An old indigenous reference generates more interest and involvement among scientists and farmers than any logical discourse. For instance, a lecture entitled "The Gospel of Dirty Hands" by a former cabinet minister and a man of literature, Dr. K. M. Munshi, very effectively communicates the principle of how middle class scientists and extension workers could lose their touch with the soil and the small farmers by not trying to soil their own hands. Similarly, an old book by Gangaben (1894) of Mansa in Gujarat, provides an excellent example of what woman's creativity can accomplish. She was a young widow when she wrote a book in 1893 that included 2080 recipes for self employment for rural youth. Many herbal pesticides, vegetable dyes, ways of storing grains are among the various ideas she wrote about. It is said that 1000 copies of this book were sold in just the first three days after publication. A reference to this book in our various meetings generates tremendous enthusiasm among field workers and farmers and communicates the need for documentation and dissemination.

Another advantage of old literature is that it generates humility. When one tries to assume a heroic role, it becomes difficult to be self critical. On the other hand, when one claims to merely extend a long tradition (say of participatory research), there is less resistance to the idea of collaborative learning. Way back in 1907, a book called *Fortune in Formulas for Firms and Farms* was published in North America. It continued to be published till 1943. This book was similar to Gangaben's in that it contained a large number of recipes for private or commercial use. There may be similar traditions in other societies and thus the first step in participatory research should be to trace the living traditions that are rooted in local culture and history. Instead of grafting on an alien terminology, concepts grounded in local philosophy, culture and traditions should be used as the initial building blocks. It is not our argument that local traditions can always provide sufficient scope for experimentation and innovation. However, there are always streams of resistance, innovation and experimentation which may be identified.

Reciprocal Framework of Research: Contingent Perspective on Participation

We began with a question about whether the koel will participate in hatching a crow's eggs. It is now time to question whether such participation is necessarily superior to the participation of the crow in hatching a koel's eggs. Often, uncovering the farmers' own experimental approaches and heuristics may be sufficient to help them to redefine the problem and devise appropriate solutions (Gupta 1989c, Gupta 1989d, Pastakia 1995). But in some cases, farmers cannot devise solutions on their own. On-station research becomes necessary and farmers will have to merely participate in evaluating results or monitoring the experiments for any counter-intuitive observations. Normatively, we should not consider one form of participation superior to the other. Thus, farmers' participation in the scientists' own experiments need not necessarily be superior to scientists' participation in farmers' research. Both forms have their own advantages and limitations. In order to evolve a contingent framework, it is necessary to match the different methods of participation with the different approaches to defining the purpose of participation. The same method, say on-farm research, may not address all kinds of problems.

Defining the Problem

It is a truism that the proper definition of a problem is half the solution. And yet, very often, we do not know whether our definition of the problem is correct or not. Let us take the case of weeds, which are considered to be a menace in rainfed crops. In the conventional definition, weeds are plants out of their place. But in nature, no plant can truly be out of its place. It is possible that we may not know the significance or role of a particular weed as a companion plant. For instance, the distribution of minerals in a field may help certain plants grow faster or slower. Thus, weeds may act as indicators of soil mineral properties (Hill & Ramsay, 1977). If we know the variability in the soil nutrient profile, we can follow precision farming which will lead to economy and efficiency in input use. Once the existing heterogeneity of nutrients is known, it is possible to study the reasons and take remedial action. Another way to look at weeds is to ask ourselves why farmers are selective in removing weeds. They obviously must be recognizing the allelopathic interactions of various plants. A good example is a weed (companion plant) called Sama (*Echinocloa colonum*) which grows on its own in paddy fields, or is cultivated in certain parts of the country. Why would farmers conserve a 'weed'? There may be several reasons: (a) it is an extremely nutritious grain suitable for consumption during fasting (b) a review of literature shows that it provides an alternative host for a few insects including leaf roller which do not affect paddy crop but get attracted to Sama and (c) some other ecological function which we are not aware of as yet. It is not without significance that farmers have conserved this weed through sociocultural mechanisms such as a particular festival, *Sama pancham*, when only grains like Sama are eaten. If sustainability requires a long time frame and a wide variety of heuristics through which our choices should be processed, then a strong case exists for understanding how farmers define a particular problem (Gupta 1981, Gupta et al., 1995).

Termites or white ants are known to be a serious problem in farming as well as in households. However, like many organic farmers, Mulchand Haria of Kachchh district, an arid region of Gujarat, sees termites as a resource. His contention is that termites never attack green living tissue. They act as scavengers and attack only tissues that have died due to some disease or physiological problems. He has been nurturing termite mounds in his organic field. He does not even allow people to cross his fields because various beneficial organisms residing in this field may be disturbed. In certain parts of West Africa, pits are dug in the fields which are to be reclaimed. Various kinds of organic matter are dumped inside and termites introduced. Soon the field is converted into a fertile plot of decomposed organic matter (TASA system).

Once, during a discussion with some farmers on the reasons for growing different varieties of paddy in seemingly similar adjacent plots, a Bangladeshi farmer mentioned that one of the two varieties gave a better yield and fetched higher prices, while the other was good for consumption. The latter variety swelled in the stomach after consumption, giving a satisfactory feeling of having eaten. He suggested that the pangs of hunger were more debilitating than nutritional imbalances. The ability of grain to swell in the stomach may not have been a criterion or a problem to be studied by the scientists so far.

Let us take another example. Storability is a characteristic of sorghum which has not been given enough attention by those who have designed the protocol of germplasm characterization in ICRISAT (Bush and Lasey 1984). When one of us (Gupta 1991b) inquired about this characteristic from the former head of the gene bank (Dr. Mangesha) in ICRISAT, it was mentioned that it was not important. But millets and sorghum are not procured for the public distribution system because the improved varieties of these crops do not have good storability. Contrast this with a particular variety whose name in the Tamil language is *irungu cholam*. The word *irungu* is derived from *irumbu* which means iron. Obviously, if farmers chose to name a red sorghum variety having high storability in this fashion, the importance they attach to the storability character is evident. The etymological roots of the names of many other local varieties may reveal similar insights about germplasm characterization. Defining a problem is a process in which whatever effort is made will always appear inadequate. Yet it is an area in which we have made very little headway.

Establishing a Causal Connection: Can Farmers Do the Right Things for the Wrong Reasons?

Often people's knowledge is decried on the grounds that it is deficient in the area of cause-effect relationships. It is not realized that many modern technologies were developed with the causal basis for the effect observed remaining a mystery. Aspirin helped in reducing headache. Why it did so was not known till recently. Farmers in parts of Haryana in northern India grew coriander around the chickpea crop. They believed that it helped in repelling pests. At our suggestion, Pimbert (1989, personal communication to Anil Gupta) pursued research on this practice in ICRISAT and found that coriander did not repel the pests but actually attracted the predators (Gupta, Patel & Shah, 1986).

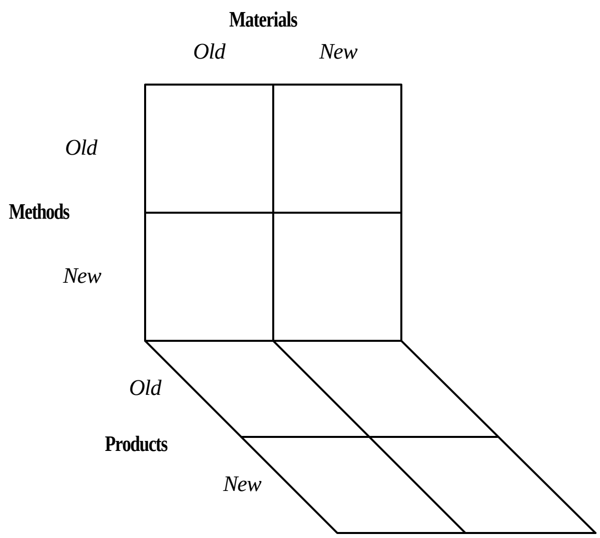
In the mid-fifties, paddy-growing Chinese farmers were suffering from the deadly disease, Schistosomiasis, which was caused by blood fluke. It affected 250 million people in Africa, Asia, Central and South America. Scientists studied the life cycle and found out that the snail was the intermediate host that helped in completing the life cycle of the blood fluke. Scientists communicated these findings to people through films, radio talk and other media. Once people knew about the habits and life cycle of the organism as well as the intermediate host, they devised numerous ways of checking them (Jousa, 1969).

In the case of the guinea worm, farmers could not identify the causal mechanism and therefore failed to control it. They did the next best thing, which is to cope. They developed methods of extracting the worm out of the body without breaking it. When scientists researched the problem, they found that people should not drink water from the ponds in which they washed their hands and feet. The worm spent part of its life cycle in the human body. By double filtering the water, the eggs could be screened out. Many more examples may be given of the role of participatory research, formal as well as informal, in understanding causal mechanisms.

Widening Alternative Choices

Primarily drawing upon the *Honey Bee* database, Pastakia (1996) studied grassroots innovators involved in sustainable pest management in order to understand their decision making processes. He identified two particular heuristics which were not reported in the formal scientific repertoire: (i) use of insect and plant material for repelling pests and (ii) increasing the growth of a crop to minimize economic damage by a pest instead of controlling the pest itself. The heuristics that the innovators used to derive such solutions included various combinations of materials, methods and products, each of which had a sustainability dimension determined by the renewability of the resources involved (Figure 1).

Figure 1. Combinational heuristics



Source: From an unpublished paper presented by Anil K. Gupta and Kirit K. Patel to scientists at Gujarat Agricultural University, Anand in 1994.

Old methods, old material and old products. Old methods, old materials and old products signify the traditional wisdom which may have relevance even for the contemporary context. For instance, *Virda* is an age-old technology for conserving rain water in a saline arid region with saline ground water. In a predominantly flat region, rain water gets stored in minor depressions or tanks. Within these tanks, the pastoralists dig shallow wells lined with frames of wood of *Prosopis juliflora* and grass. Just ten inches of rainfall provide sufficient fresh water which remains above the saline ground water inside the wells. The *virdas* are covered with silt and sealed. They are opened, one at a time, depending upon the need. The water remains sweet for two to three months, after which it turns saline due to the upward movement of saline water. This technology has enabled the pastoralists in Banni pastures to survive for several centuries. The season's rain may fall within a few days, hence the need for a robust, efficient and adaptive strategy (Chokkakul & Patel, 1994; Ferroukhi & Suthar, 1994).

In such a case, modern science does not merely help explain the functional viability of the technology, but also provides a basis for abstraction and generalization. For instance, once the properties of wood and grass, the pressure that the walls will need to cope with, the infiltration rate and the functions of the saline soil in holding the salts are explained, the search for other materials and methods for similar outputs may begin. There is very little advantage that the prior art of knowledge in modern science can provide while dealing with such complex questions of survival in difficult regions.

Old methods, old materials and new products. The hair which constitutes the mane of camels is known to be very hardy and resistant to corrosion. Traditionally, the pastoralists make different kinds of ropes, carpets and bags out of this hair. Once science figured out the use of these carpets as oil filters in oil refineries, a new product was developed from the old method and material. Similarly, sisal rope has been used in various activities, both for commercial and domestic purposes. It was found that these ropes can withstand corrosion better than any other material in the sea. Thus a new use for material grown in poor soils is generated. The processing of sisal is very painful because of the various tannins released into the water in which sisal plants are immersed for some time. When the fibre is taken out, these tannins cause blisters on the hand. Simple technologies have been developed to take the fibre out without hurting the hands. Modern science can blend in with the traditional methods while leaving other choices intact.

New methods, old materials and old products. In many of the cumin-growing regions, farmers had observed that the plots on the roadside were more productive than the ones in the interior. They figured out that the dust which settled on the plants saved them from certain pests and fungal diseases. Some other farmers observed a similar phenomenon near brick kilns. Dusting with ash or fine soil thus became a new method for controlling pest and fungal diseases in this crop. In many other crops, the use of ash as a dusting material is well known.

Similarly, the case of termite control using cut immature sorghum stalks in irrigation channels, reported earlier in this paper, opens up a new field of research. So far, sorghum breeders had been looking for landraces with a low hydrocyanide content. This innovation opens up the opportunity for selecting high hydrocyanide content sorghum lines. If this technology works in different parts of the world, dry farmers may very well grow a small patch of such sorghum for pest control purposes.

Old methods, new materials and new products or uses. Some innovative farmers have used a drip of castor oil (a tin box with a wick hanging over an irrigation channel). The oil drips into the water and spreads into the soil, adding luster to the banana crop. This drip is also used in other crops for soil-based pest control.

Examples of the other combinations may also be found. What these examples show is that farmers can be extremely creative in solving local problems. But the issue is whether their knowledge systems can be blended with formal scientific research. One block may possibly be the tension between the farmers' interest in solving the problem and the scientists' interest in developing a new theory. For instance, a farmer, Khodidasbhai, after reading about three different practices for controlling a pest in a local version of *Honey Bee*, used all three on the same crop, in the same season, but sequentially. It is quite possible that scientists would not attempt such an experiment in order to avoid a complicated design with confusing results. Learning to break old rules, which formal training does not easily permit, can be a useful purpose of participatory research.

Institutional and Technological Cycles

Institutional constraints can be precursors of technological change and *vice versa*. In fact the process may even be cyclical, with an institutional constraint providing a spur for technological solutions, which in turn lead to an institutional innovation. Sometimes, both technological and institutional change may take place simultaneously. It has been argued that technology may be likened to words and institution to grammar (Gupta, 1991d). We cannot make much sense of one without the other. In the literature on participatory research, the interface of institutions with the process of technology generation has not been adequately addressed. Therefore, we will provide illustrations from the *Honey Bee* database in order to strengthen the case for modifying the framework for participatory technology development (Tables 1 and 2).

Table 1. Technological triggers of institutional innovations

No.	Problem	Technological need	Institutional innovation
1	Pasture degradation due to trampling of grasses and grazing of seedlings by small ruminants	Either grasses should withstand trampling or they should regenerate in spite of damage	In Takuva village of Gujarat, farmers persuaded sheep and goat owners not to graze their animals for two months after rains when grass/ seedlings are tender
2	Locust attacks	Use insecticide, antifeedant or repellent to minimize damage	Farmers beat drums or bang vessels collectively to prevent locusts from settling on their fields
3	Silting of ponds	Mechanical desilting or catchment treatment	Collective action through religious or other motivation to manually desilt ponds (Saurashtra and Golden Temple)
4	Salinisation of soil in Gujarat	Soil reclamation and drainage	Pooling of private fields and agro-forestry with salt-tolerant species
5	Red rot of sugarcane and sorghum	Control of fungal spores in the crop residue	Burning of residues on a particular day in all the fields
6	Foot and mouth disease in cattle	Develop effective control agents	Quarantining diseased animals; separate grazing and watering

The cases presented in Tables 1 and 2 show that technology and institutions are interdependent and trigger changes in each other. The changes may be simultaneous or may follow a sequence. For instance, the failure of village institutions to protect crops from grazing animals led to the innovation of seed treatment with butter milk. This treatment, however, led to another institutional change, the development of a sanction against the innovator, since there was a risk of the death of animals due to accidental browsing on the treated plants. Again this sanction may encourage innovative pastoralists to find out some way of identifying the treated crops. This sequence of constraints in one subsystem leading to innovation in another may continue till the limits of ingenuity are reached. The challenge is to determine whether one should adapt to a given technological constraint through an institutional innovation or evolve a technological solution to what may essentially be an institutional problem.

Table 2. Institutional triggers of technological innovations

No.	Problem	Institutional need	Technological innovation
1	Protection of crop from animals of migrating graziers	Evolving agreements between pastoralists and farmers to respect respective boundaries	Farmers treat seed of castor with butter milk which induces toxicity in leaves, requiring animals to be kept away
2	Protection of trees planted by individuals in common lands	Community action for protection of seedlings from grazing animals	A tree-planting entrepreneur devised machines to scatter seeds of tree species not touched by animals
3	Red rot disease of sorghum and sugarcane	Non-cooperation of farmers for burning residues on a particular day	Evolution of indigenous seed treatment for preventing disease
4	Fair distribution of water	Difficulty in supervising each other's withdrawal of ground water	In the Zuni community, sticks are provided to every user who cuts a particular portion after every use so as to keep a record of water used
5	Pooling of bullocks becomes difficult	How to generate incentives for pooling	Development of single-bullock drawn farm equipment

In many villages in North Gujarat, farmers had to give up commercial hybrid seed production because of the failure of institutional support for isolation from other farmers. In such cases of participatory technology development, we may need to emphasize the institutional requirements. The technological response to this problem can be the incorporation of the apomexis gene in hybrids so that they can be grown every year like a self-pollinated crop.

In participatory research processes there is generally a tendency to underestimate institutional problems and to invest more resources in solving technological problems. The watershed research program is a classic case of such a bias. Many natural scientists do not pay attention to institutional dynamics and the management of common property resources. Institutional analysis may require an understanding of boundary rules, resource allocation rules, governance rules, conflict resolution rules, and conflict resolution rules, which is usually not in the province of natural scientists. Sustainable pest management, management of ground water as well as surface water, are other areas which require group action (Gupta, 1985b; Gupta, 1992; Sinha et al., 1996).

A key factor in understanding institutional dynamics is uncovering the actual preferences *vis-à-vis* the articulated ones at the level of the individual as well as of the group. For instance, Sanghi and Rao (1982) and Sanghi (1987) tried to relax each of the constraints that farmers reported for not trying a dryland technology. When each constraint had been relaxed, and the technology was still not being tried, it became obvious that farmers were skeptical about the suitability of the technology. Sanghi and Rao (1982) provide a good example of how institutional dynamics can be facilitated by incorporating traditional knowledge in the technology development process. They found that sowing the crops with the pre-monsoon rains, as practiced by some farmers, ensured the efficient utilization of mineralized nitrogen, avoided pests like shoot fly and ear bug in sorghum, and ensured the timely sowing of subsequent crops. In summary, the understanding of the interaction between technology and institutions is an essential aspect of developing a participatory research program.

Coping with Risk: Dealing with Household, Technological, Institutional and Cultural Risks

In high risk environments, any participatory research approach can have relevance only if it can strengthen the existing risk adjustment strategies of the different classes of farmers. These strategies can be analyzed at household, technological, institutional and cultural level.[1]

Household risk adjustment strategies:

Intra-household:	asset disposal, migration, reduction or modification of consumption, reallocation of resources among different enterprises, etc.
Inter-household:	labor, credit, land-related bilateral or multilateral contracts, informal sharing, gifts, etc.
Group or communal:	reliance on common property resources, group ploughing, sowing or other farm operations, like plant protection, drainage, purity of breed, group-level grain, fuel wood and resource reserves, etc.
Public Interventions:	drought or flood relief, aerial spray for plant protection, distribution of seed or seedlings after natural catastrophes, infrastructural interventions
Cultural artifacts:	myths, folklore, religious or other sanctions against private profit from community deprivation or for sustainable resource management, use of lunar calendar to synchronize farm operations, informal co-operation through cultural rituals regulating resource use

Technological adjustments:

Agronomic:	dry sowing, early sowing, to break synchrony in the vulnerable stage of crop and virulent stage of pest, summer ploughing, cropping, contour ploughing and sowing, inter- and mixed cropping, mixed *aus* and *aman* sowing (in paddy), laddering and planking, sowing in set and furrow system, watershed technology etc.
Contingency:	in many regions, the probability of some major treatments or risks can be anticipated and accordingly provided for through mid-course correction. For instance, relay cropping, thinning plant population after stress, mulching (it can be both, a regular practice or a contingency practice), devegetation

[1] Source: Gupta 1989e; Gupta, 1990; Gupta *et al*., 1995.

Salvage treatments: once a crop or some other enterprise suffers a shock or disturbance, technology may be required to recover from the losses. For instance, in flood-prone regions, cold temperatures at the grain feeling stage may cause sterility for which harvesting crop as fodder and ratooning may help; in flood-damaged areas, cutting and sowing of the stem of the surviving plants may help

Preventive treatments: several indigenous ways of seed treatment by organic gels and other materials exist to minimize drought and pest damage, border and trap crops for pest control, indigenous vaccination among animals

Institutional risk adjustments:

Spatial: the banks can lend to less risky villages, scientists can locate trials at less risky sites, the input agencies may locate distribution points in less risky regions because of larger demand

Seasonal: the lending can be constrained in the monsoon season, input supply may be erratic and inventory level low or nil in *kharif* season, the banking disbursements may be clustered around the financial year-end even if results are suboptimal

Sectoral: loans for nonfarm purposes, rainfed crops, small ruminants, long gestation investments like watershed treatments, etc., may be highly restricted. Credit for various purposes may be clustered even though there may not be a rational justification for such a portfolio

Procedural: high margins, insistence on collaterals, shorter repayment schedules (even though this practice may eventually increase the default risk), multi-enterprise loans, linkage between investment and working capital loans, group guarantees, saving and lending groups, linking banking and technology

Background risks: deposit and credit insurance and guarantees, crop and other enterprise insurance, failed-well subsidy

Cultural risk adjustments:

Collective action: group-based management of resources such as water streams in hills, plant protection, watershed management, grazing land and common property resource management, rotating saving and credit associations and use of discount money for common property assets such as temples, school furnishings, pesticide sprayer, group norms for collecting fuel wood or roofing material on particular days in the hills

Folk rituals: several folk songs, myths, stories, proverbs, are used to generate psychological assurance or social resilience in the local communities; attitude formation and generation of an eco-ethic is also facilitated by folk media

Institution building: seneration of norms and values suggesting respect for common properties and participatory processes of decision making aid risk adjustments; pooling of bullocks, implements and other resources also facilitated by institution building processes

It is obvious that one cannot incorporate the entire range of risk adjustment choices in any one program. However, it will be useful to jointly identify those risks that are important and agree on how to cope with them, without minimizing the potential for technological upgradation.

Evaluation and Interpretation: Comparing and Contrasting Local Variability

Scientists can evaluate the experiments of the farmers and *vice versa*. Ashby *et al*. (1987) described ways in which farmers evaluated the potential of different varieties developed by the scientists. It is not just the judgments that one can learn from participatory exercises; the opportunity to learn about the criteria for making judgments is much more important. One of the methods that has been suggested for developing an empirical understanding of the local variance in resource use and coping strategies is a kind of manual discriminant analysis together with ecological mapping (Gupta 1987a, 1988).

The manual discriminant analysis (MDA) relies upon a simple premise, which is that, in any distribution, if we can compare and contrast the observation on the tails (i.e. extremes), we can understand reasonably well plus or minus one or two standard deviations. For instance, we can array the current resource-use patterns in a spreadsheet for each plot of every household. Having done that, we can look at the extreme values. Then, for instance, we can ask the five farmers who had sown earliest to explain individually why the five or ten such farmers who sowed last actually did so. Having asked about the reasons for a practice which is opposite to one's own, the frame of reference of the respondent farmer can be calibrated. After this, if we ask the same farmer to explain the reasons for his early sowing, we would probably get much more authentic information. This process may help generate hypotheses for further on-farm research or surveys. In a study on matching farmers' concerns, technologies and objectives (Gupta 1986b), it was found that, contrary to common belief, the criteria for specific choices such as sowing time in a rainfed crop may be determined to a greater extent by ecological factors rather than socioeconomic or cultural factors. In this study, an interesting determinant of the sowing time of mustard was the fallowing in the previous season, and not the access to credit or land or other inputs.

Similarly, ecological maps can help us identify the niches for different varieties. If the macro environment and local land races are closely inter-linked, by mapping one, say the varieties, we have mapped the other, i.e., the macro environment (Gupta, 1989a; Gupta, 1989b).

Scaling up of Technology

Just as different scientists have varying aptitudes for doing pioneering or repetitive research, different farmers also have a variety of attitudes to the development or scaling up of the technology. Some are content with whatever work they have done. Identifying the farmers who may like to scale up a technology need not necessarily mean identifying the privileged or big farmers.

Participatory Breeding Research

If we do not read the `book of diversity' embedded in local knowledge properly or adequately, we stand to lose much of the information available in nature and within local communities. Most breeders have not documented information regarding the providers of landrace resources or the culinary characteristics perceived to be important by local people. They often find it difficult to recall the selection criteria used by the local communities. This has resulted in inadequacies in the passport information sheets maintained in the gene banks. In the absence of information about providers, it would be very difficult to revisit the exact sites and to ensure that any benefits that may arise as a result of value addition are shared. SRISTI arranged an informal network meeting last year with scientists of GAU to correct these problems (Anonymous, 1995). We are keen to establish contact with other groups working on similar ideas.

In the case of animal germplasm, the situation is even more serious. Unlike crops, where a small sample of seeds, selected properly, may capture a large part of the variance of the population, a very large sample is needed in the case of animals to achieve the same result. Most ex-situ gene banks have very few animals of different breeds. The passport information sheets for animal germplasm are even more inadequate than those for plants.

The Honey Bee network has tried to address these gaps in the characterization of germplasm. The recent FAO initiative on developing DADIS (Domestic Animal Diversity Information Systems) is trying to overcome these inadequacies in a very participative manner.

Building upon local knowledge: towards participative breeding. The challenge, however, is how to make gene bank information accessible to the local communities in a form which is easily understandable and comprehensible. Also, information should flow back in such a form that breeders take note of people's knowledge. An important issue is the access of local people to material that would be useful for their own breeding programs. If communities and individuals have been developing distinguished landraces and animal breeds in the past, there is no reason why they cannot continue to do so in the future. The challenge of participative breeding is important for several other reasons:

- A very small proportion of the landraces available in a local gene bank is used in the breeding program of a crop.
- Ecological heterogeneity in rainfed regions and the location-specific differences even in irrigated regions (arising as a result of mineral deficiencies, changes in the water table, pest and disease regimes, drainage profile) require that breeding for local specificity becomes a paramount goal.

- Formal institutions all over the world are under severe resource constraints. It is unlikely that they will have the resources to expand on-station research facilities. Participatory on-farm research is thus inevitable.
- A large amount of improved genetic variability in the form of F7 or F8 generations/ advance lines is rejected today because of its inability to surpass the available checks (control varieties). Many of these lines may prove to be suitable for different locations.
- The selection criteria of farmers, which may be different from those of scientists, may provide sources of variability for improvement programmes. In a study on Matching Farmers' Concerns with Technologists' Objectives (Gupta, Patel & Shah 1986), we found that the harvest index in millets preferred by marginal farmers was much lower than that preferred by the bigger farmers. This realization has dawned on the institutional scientists only recently.
- Farmers might prefer technologies that reduce risk, not necessarily to the scientifically-acceptable levels of 95 per cent, but maybe to lower levels of 80 or 75 per cent, if the associated increase in cost is not too much.
- Participatory breeding also makes it possible to incorporate the women's perspective on farm operations, postharvest processing and cooking attributes.
- Farmers’ innovations for the management of pest and disease, nutrients, weeds, documented through the Honey Bee network, could be screened using the farmers' criteria. This will help us in developing varieties which respond to nonchemical external inputs. It may also mean re-ordering breeding priorities in some cases. The example of cut stalks of sorghum to control termites was mentioned earlier.
- Farmers’ own selections from local and external material have led in the past to the development of new varieties. This potential is grossly underutilized. Two examples would suffice: Thakarshibhai of Junagadh district of Gujarat suffered, as did many others, during the 1987 drought, one of the worst in decades. The government distributed groundnut seeds to counter the shortage of seeds. Thakarshi found two or three unusual plants in the crop he grew with these seeds. He selected them and developed a variety in which the pods are slightly curved, very compact and the grains quite bold. Each pod has two grains. The new variety was called morla, which in the local language means 'curved'. Several farmers have bought this seed. Similarly, Rajabhai, another farmer from the same district, had developed another variety from some unusual groundnut plants he had found.
- Many of the crops in marginal environments are grown as mixed crops. However, when breeders develop varieties, they often assume monocrop conditions first, and only later on try to generate intercrop combinations. Participatory breeding makes it possible for breeders to select under farmers' management conditions.
- It is well known that the economy of rainfed farmers is primarily dependent upon livestock. Yet, most of the crop varieties are screened on the basis of grain yield alone. By working with the farmers, scientists can get quick feedback on attributes like fodder quality, thereby making mid-course corrections possible.

What has been said above about the benefits of participatory breeding raises certain larger issues about the exchange of germplasm and conservation of diversity. The dangers of a narrow genetic base in the high-yielding varieties of paddy are well known. But such dangers are not new. The potato blight of the Irish Famine of the mid-19th century, and the corn failure in USA in 1974, are well-known examples. But the public response to such issues is always very slow. Even after the CBD, FAO Undertaking and many other national and international meetings on the subject, public policy remains very muted. Assuming that this situation is likely to change in the post GATT/ WTO environment, we must address the following issues:

- What are the biological, social and cultural bases of the exchange of germplasm among farmers? What is the role of farmers' knowledge about seed and soil-borne diseases, root exudates and their effects on seed specific microbial diversity, in triggering such exchanges?
- Seed exchanges across cultures and communities were part of the rituals in several communities. How has the erosion of these rituals in the process of modernization affected the exchange processes?
- The selection criteria for different crops have involved ingenious ways of incorporating agroecosystems and socioecological requirements into the selection process. The example of millet selection was mentioned above. How should the changes in the farming systems be related to the changes in the selection criteria?
- Will the restrictions on seed saving and exchange rights under UPOV 1991 affect the traditional diversity-creating processes? In which regions and crops are these restrictions likely to have maximum effect (allowing for the fact that the restrictions will apply only to protected seeds)?
- How does the frequency of exchanges, within and among communities, depend upon the degree of variance in the gene pools of the respective populations? Can one hypothesize that, higher the variance in a given crop culture, higher will be the tendency for seed exchange? If so, can one use this practice as an index of the buffering nature of the population?
- Not everyone in a village grows the local landraces. Conservation strategies cannot be developed without understanding the nature and the extent of the buffering of gene populations in a given landrace, over space and time. Should one conserve, in one or two villages, all the ecotypes grown, or should a sample of plots in different villages spread over large areas be used? How should such a sample be selected? These questions have not been empirically answered. They are also relevant if we have to develop incentive systems for growers of landraces.
- Since much of the production in the high biodiversity and economically poorer regions is organic, compensation systems for landrace growers may include (i) organic certification systems in order to add value to the production and (ii) market research for generating demand? These steps imply that consumers will pay directly for conserving diversity. In any case, no long-term strategy can be developed for conserving diversity unless consumer demand for diverse tastes, shapes, colours and smells is generated and promoted by the elite role models.

A differential price incentive system could be tried. Thus, growers of landraces in a specified area could be paid the additional income they would have got if they had replaced the local landraces with high-yielding varieties.

The value addition in local varieties through decentralized units may also contribute to the conservation of diversity. The example of French wines, often made from grapes grown on very small and specific plots, is a rare case of market forces contributing positively to the conservation of diversity (Gupta 1991a).

- Can multimedia data bases on local diversity, for different regions and crops, be developed so that farmers could make selections from the available gene pool and undertake multilocation trials? Other approaches to achieve the same end may also be tried: different groups of male and female farmers may be taken to research stations to make selections from the ex situ gene banks; pursuing parallel selections by breeders as well as farmers and taking both the populations to advanced generation to see whether some distinct genetic advance is achieved by farmers' intuitive as well as explicit selection criteria, and so on.

  Maurya (1988, personal communication to Anil Gupta) tried to give the excess seeds of the advanced lines, after matching their characteristics with the local varieties of paddy, another chance in the farmers' fields (it is a pity that Bottral and Farrington in a joint paper with Maurya tried to put far more method into this simple and innovative approach of Maurya's and distorted the actual process and its implications). He monitored the farmer-to-farmer diffusion of such seeds and assessed the suitability of different advanced line seeds for the farmers' microclimatic niches. The assumption was that such a variety of conditions would not be available at research stations. Unfortunately, due to the interference and opportunism of the donor agency concerned, a very useful approach was prevented from being fully developed. The selections of farmers from the material which the breeders had rejected, were perhaps not taken up for systematic trials at the research stations. This is an approach which does have merit and needs to be further developed.
- Studies have shown that breeders have no incentive for breeding varieties with limited potential for diffusion. In other words, improvement programs do not reward conservation or the augmentation of diversity. How should incentives be developed so that breeders are not rewarded only for varieties that diffuse over a large areas?
- To enhance variability in a crop complex, farmers in many cases plant different species of the same crop together to promote some kind of interspecific hybridization as shown in the case of paddy species in Sierra Leone (Richards 1985). Similarly, sometimes farmers realize the relationship between crop diversity and the so-called weed (or companion plant) diversity. In such cases, one could not consider conserving crop diversity without understanding and maintaining the diversity of companion crops or plants. How we should relate these two kinds of diversity is an underexplored issue.

- Variations in crop populations can be reduced or enhanced by various innovative strategies. Dr. Richaria has reported that, in a tribal region of Madhya Pradesh, a traditional healer, after following certain rituals, gave a particular kind of seed to different farmers as a sort of blessing. These seeds were to be grown along with whatever variety of paddy the farmers cultivated. It was later discovered that the distributed seeds were of a male sterile line which enabled a kind of hybridization in the farmers' fields. Dr. Richaria has also shown that by following the clonal propagation method, farmers selected the best plant and filled the entire field with the tillers of the same mother plant. This technique created a positive stress and enhanced the yield. The conservation of germplasm will require a careful study of such strategies of enhancing or reducing diversity in a field, and possibly increasing diversity in the populations.

There are many other issues in conservation, variation, selection, and exchange of germplasm which have not received adequate attention in the literature. Farmers' groups have been known to reward outstanding breeders of local varieties in farmer fairs in different parts of the world. Thus a culture of excellence does exist among the farmers. These issues need to form part of the agenda of participatory breeding research.

The foregoing paragraphs have dealt with a framework of participation that included defining the problem, working out causal links, examining the alternative choices open to farmers, combining the interplay between technological and institutional factors, strengthening risk-adjustment strategies, the issues of evaluation and interpretation, the question of the scaling up of technology and participatory breeding research. In the rest of this section, some of the models of participatory research experimented with by the Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI) are described.

Venture Capital Fund for Small Innovations

The absence of a venture capital fund is a major handicap in testing out the small-scale innovations of farmers and artisans. An example of an innovation that has the potential to become commercially viable, and an experiment in supporting the development of the design of an innovative bullock cart are described briefly below.

Case 1: Sowing Box

Amrutbhai Agrawat is an artisan in the village of Pikhor, district Junagadh, Gujarat. He has developed several innovative farm implements such as a wheat sowing box and groundnut digger. Most sowing equipment has a bottom part in the shape of a pipe which discharges seeds. The metering devices are located in the seed box. In dry regions, which also experience strong winds, lodging can be a problem in irrigated fields. Amrutbhai devised a box to spread the seeds in a strip. While the seed rate *remains constant, the distance between the seeds is increased so that they do not fall one over another. With better root growth there is a more efficient nutrient uptake and also the crop does not lodge. In addition, if there is water stress, the crop is able to withstand it better, because of the stronger root network. He has also designed a groundnut digger with a flexible blade hoe which can be adjusted to change the distance between the two rows as well as to modify the depth to which hoe enters the soil to uproot the groundnut pods.*

Case 2: Tilting Bullock Cart and SRISTI Venture Capital Support Fund

Amrutbhai had an idea about solving another problem that has remained unsolved for centuries. In most tropical plain lands, farmers have to carry the farm yard manure in a cart to a point in the field. After pouring the manure out in the field, farmers have to scatter it with the help of baskets. This consumes a lot of labor and time. He thought that if a modification could be made in the design of the bullock cart, a farmer could easily tilt the cart and distribute the manure slowly, over the entire field. This idea was worthy of support by a Venture Capital Fund (VCF). SRISTI, with the support of an IDRC grant, decided to experiment with the idea of VCF. A proposal was prepared and reviewed by two knowledgeable persons. And, eventually, the cart was developed. As reported above, many inquiries have been received and the first cart has been bought by an agricultural university. A large number of other ideas and inventions remain undeveloped or inadequately developed for want of VCF support.

Access to Information: Local Language Versions of Honey Bee

Apart from the ethical requirement that cross-communication among farmers takes place, the practical spin-off may also be of help. A native American farmer, Janice Blue, after reading about a particular horticultural practice, did an experiment on her own. Similarly, a farmer from Puerto Rico, Judith von Riper wrote to us about the possible use of the bullock cart described above in her country. Apparently, there is no North and South when it comes to sustainable technologies.

Bringing Experimenters Together

Often, the idea of one farmer may be modified by another farmer, and operationalized by yet another farmer. For instance, Badribhai wanted to develop a bullock-drawn sprayer for herbal pesticide. However, we found out that such a contraption did exist. Without this cross-connection, he and his artisan friends would have wasted their resources. A workshop of artisans and professional scientists was organized to discuss what modifications could be made to the design of the pulley used by millions of women daily for lifting water from wells. It was realized that when women draw water they use up energy not only in lifting the bucket, but also in holding it in its place while taking deep breaths.

Trust Fund

In many cases, when grassroots innovators and biodiversity experts will not accept any monetary compensation, setting up trust funds provide a way of augmenting local experimental knowledge systems. Karimbhai, whose example was cited earlier, is one such innovator under whose leadership a trust fund was set up. Such funds can be of use when group-based experimentation has to be undertaken.

Linking Private and Public Sector Research

Many ideas developed by farmers may require further research. Organizations interested in value addition and the commercialization of technologies can help in this regard. Unfortunately, building partnerships with the private sector has not received adequate attention.

Rewarding Innovators

Compensating or rewarding people who have conserved natural resources, even while remaining trapped in poverty, has become an important issue, especially after the discussions on the Uruguay Round and the signing of the Convention on Biological Diversity. The desirability of evolving stronger intellectual property laws has been questioned by some people who perhaps believe that the continuation of a patronizing and protective regime is what the poor want to see. These people have no faith in the native genius and they argue that since we have never won a global struggle in the past, there is no guarantee that we will do so in the future. But those who have faith in the intellectual richness of local communities and individuals would like to use the evolving intellectual property regime to ensure higher returns for the innovators through a system of patents, trade secrets, contracts, licensing and so on.

We have been pleading for a global registration of local innovations, traditional knowledge and practices for the last several years (Gupta, 1991; Gupta, 1995c). The Third World Network also endorsed this idea, but restricted its application to collectives only. In contrast, we believe that individual innovators do exist, even in communities where communitarian knowledge is strong. These people would need to be compensated for their efforts. The proposed registry, International Network for Sustainable Technological Applications and Registration (INSTAR), would result in the following benefits:

- acknowledging individual and collective creativity;
- entitling innovators to a share of the returns from future commercialization;
- linking investments, enterprise and innovations -- the three corners of the triangle of entrepreneurship. This kind of networking will make it possible for small innovators to take advantage of the benefits of scale;
- regulating access to contracts by an autonomous authority that has a strong representation of local community representatives. This authority can keep copies of all contracts and monitor the sustainable extraction of resources;
- coding each entry in the register. This should include the postal code of the innovator, so that identifying the location of the innovator is possible;
- to begin with, the entries may only acknowledge the creativity and innovation. Later on, some of the innovations may be awarded inventor certificates or a petty patent that affords limited protection for a limited period of time;
- inventor certificates should also help in obtaining concessional credit and risk cover, so that the transition of the inventor into a producer or marketer is possible;
- the registration should also become a part of the Knowledge Network mentioned earlier. The Network can serve as a clearing house for various communities.

The registration system is only one aspect of a system of incentives and rewards to innovators. A broader framework of compensation would include the following elements (Gupta, 1995a, 1995b & 1994c): (illustrative examples are provided for each category)

Figure 2: Scheme of compensation/reward

		Nature of compensation/reward	
		Material	Non-material
Compensation/ reward receiver	Individual	Patents Royalty License fee	Honors Gate-keeping function
	Community	Trust funds Risk fund Insurance	Education Curriculum reform

Some of the ways of generating revenue for the various incentives are the following:

- a cess or tax on the sales of seeds derived from germplasm conserved and contributed by specific individuals or communities;
- a share in the turnover of commercializable plant-derived products, like herbal pesticides, veterinary medicines, dyes, antioxidants;
- a tax on the market arrivals in grain markets in the green revolution areas;
- a license fee to be collected from public and private sector companies for using germplasm still conserved by communities in backward regions, even if this germplasm is available in national and international gene banks;
- infrastructural investments in education and other basic needs.

There could be other ways of generating revenue. The crucial point is that one cannot expect poor people to conserve natural resources for ever and ever, while they remain in poverty.

Learning from Women Innovators: Does Gender Make a Difference to the Nature of Indigenous Knowledge?

This final section summarizes some of our reflections on the relationship of gender with indigenous knowledge, in the context of participatory research. These are tentative and cannot be treated as definitive. There are certain patterns in knowledge systems on account of gender, and there can be no doubt that the parameters of a technology that minimizes the vulnerability on account of gender and/ or poverty in the market place will have to receive greater attention while developing innovations.

It is a truism that women have much better grounded knowledge of the practices in which they are primarily engaged. Thus, seed storage, postharvest processing of grains, livestock hygiene and husbandry, the marketing of certain kinds of trinkets or farm produce, household recipes, are examples of this kind of specialization. Whether the knowledge so produced is affected more by the specialization or gender is not an easy question to answer. Two examples which illustrate some of the issues are presented below.

Making tubers round and storable

In Tangail district of Bangladesh, we (Gupta, 1987d) observed one woman who had set up a nursery of sweet potato on a small patch of land. She planned to transplant the sweet potato in land which she hoped to get on lease. In case she did not get the land, she would continue to grow the crop so that she could feed her family sweet potato when rice became difficult to get. While cutting the sweet potato vines, she was *also de-rooting them at the nodes, leaving only one or two roots. Her reason for leaving only one or two tubers at each node was that this practice resulted in rounder tubers which had thick skins. The round shape was preferred by consumers and the thickness of the skin helped in prolonging the storage life of the tuber. These criteria were not incorporated in the selection criteria of sweet potato at either national or international research institutes. Obviously, the practice made a lot of sense and helped overcome some very specific constraints.*

Winter irrigation of arecanut through banana

Ms. Dilruba, an oilseed breeder, made a case study of women farmers in northern Bangladesh. She found a very interesting practice for providing moisture to arecanut trees during winter when there was hardly any rain and the sandy soils created dry conditions. A banana plant was planted between four arecanut trees. The suckers of the banana absorbed moisture during the rainy season and released it to the roots of arecanut during the winter season. Obviously, this is a very sustainable practice (Gupta 1987e).

Participatory research should not merely emphasize the work that women do. Not because the work women do is not important, but because an emphasis on work detracts from the very necessary recognition of the intellectual contribution of women. Many women develop insights during the course of their work; these will become available for building upon only when there is a valorization of the intellectual capacities of women. For instance, the criteria for selecting seeds, practices of animal care, food processing and the consequent preferences for different kinds of blending of various food materials, are useful starting points for building in women's perspectives in research. We have also seen that the articulation of women's knowledge often best takes place within women's own networks. There is no judgment involved in this statement; it just so happens that the way in which society has developed in the past perhaps makes this option optimal, at least for the present. Of course, this cannot be generalized for all cultures.

One should not try to ascribe a value base to women’s practices that is entirely different from the one that is ascribed to men. For instance, women money-lenders are known to be as unfair to poor women borrowers as men money-lenders (Gupta, 1983). Similarly, women can be as secretive about their recipes as men are. However, the different experiences of women, and the culturally-specific socialization processes that they undergo, do make for a uniqueness in women’s perception of the relationship between nature and day-to-day existence. To that extent, a case for the feminization of the research agenda can be made. This is essential in order to correct the prejudices that have hindered the rate of technological change in many of the activities that women perform. A good example, reported above, is the design of pulley used by millions of women for drawing water from wells. It should be possible to make a ratchet mechanism which reduces the burden that women have to bear while pulling up buckets of water. Unfortunately, we are not aware of any large scale use of improved pulleys. The workshop of artisans, cited above, did suggest some changes, but they need to be followed up. Some of the approaches which appear necessary in a gender-sensitive participatory research agenda include the following:

- Focusing on the problems of the regions, sectors and enterprises in which women have to bear the highest burden;[2 3]
- Identifying differences in the relative weights that men and women attach to the different kinds of consumption of the various family members;[4]
- More involvement of women in the management of certain enterprises, like livestock, food processing, seed processing, may result in the development of unique skills.[5] Many women distinguish between the waters of different wells; for instance, the water of a particular well may be used for cooking pigeon pea, which takes a long time to cook;
- Recognition of the differences in the articulation of preferences, individually or collectively, spontaneously or through iterative interaction;[6]
- Gender aspects need not necessarily only imply contrasts, they may also indicate complementarity.

[2] When we reviewed the curriculum of some of the leading women's studies programs in the country, we did not find any reference to women's unique indigenous knowledge in the technological, educational or institutional fields. There is no recognition of the fact that the proportion of women-headed or managed households is much higher in drought-prone regions, hill areas, forest fringe areas and flood-prone regions.

[3] In a drought-prone region, it was noted that women grass sellers become more vulnerable when they try to negotiate prices in the evening, because of the compulsion to return to home before it gets too late.

[4] Studies have shown that women give greater weight to consumption than men, though they may discriminate in favor of sons over daughters in some cultures. Similarly, they seem to prefer fruit species over timber species, in contrast to the men. Even in terms of allocation of household expenditure, women would tend to use different allocation criteria, constrained of course by culture, socialization and family histories.

[5] If most sale and purchase transactions of cattle are done by men and of backyard poultry by women, it is reasonable to assume that knowledge about selection criteria relevant to the different species will also vary. Similarly, the nurturing role of women gets manifested most in livestock care, where the individual idiosyncrasies of different animals are tolerated to a greater extent by women than men. Paradoxically, this is a trait which men may show in no small measure in the case of horses, bullocks and other animals with which they spend more time.

[6] This constraint applies to men as well, though it is applied more often to women. This also suggests that rapid methods, which emphasize group interaction more than individual interaction, may generate a false understanding of the general concerns. The difference between espoused theories and theories-in-use is well documented in literature. Studies on participatory research have ignored this aspect.

Conclusion

We have been arguing for almost a decade now that the very model of technology development and transfer needs to change as far as the problems of high-risk environments are concerned. The essential argument is that, given the high ecological variability in such environments, developing technologies for different niches through the classical models of on-station research is impossible. Budgetary constraints prevent large-scale on-farm research by the public sector scientists. What, then, is the choice?

We have to identify the best solutions, derived locally, to any technological problem, understand their scientific bases, add value to them, and then share the value-added scientific principles with the farmers. The technologies will be developed by the farmers through their own research which may or may not be monitored by scientists. This approach is different from the farmer-back-to-farmer or similar approaches, because the emphasis here is on transferring science, and not technology, to farmers. Also, as argued elsewhere (Gupta 1980), it is not enough to look at just two-way communication between farmers and scientists. One must convert this pattern into a genuine two-way power arrangement in which reciprocities may be ensured. A brief example would illustrate this point. In southern Bangladesh, we observed that paddy farmers increased the number of hills per square metre and also the number of seedlings per hill as the transplanting was postponed due to a delay in the receding of the water. Their aim was to optimize the number of ear-bearing tillers per unit area. Scientists then calculated an equation by which one could work out by how much the number of seedlings and hills per unit area needed to be increased, for a given period of delay. The other contingent conditions that influenced this coefficient were also specified. In other words, an approach which takes the route of farmer innovation-science-farmer innovation is desirable for promoting sustainable development.

The real challenge for sustaining the intellectual participation is to nurture and build a culture of experimentation. SRISTI and the *Honey Bee* network have been trying to meet this challenge through initiatives like the *shodh sankal* (network of seekers or experimenters). Such fora can provide a space for innovators to share their successes and failures. They can also identify and reward innovators. We hope to intensify our efforts in strengthening such networks.

Finally, we would like to state that an excessive reliance on the classical research approach is like driving with the help of only a rear view mirror. We can see the road traveled, but the road ahead will not be visible. The excessive focus on the politically well-organized farmers of irrigated and input-intensive regions has darkened the front view glass. Thus, in addition to recalibrating our route maps, we need to perhaps redesign the vehicle itself.

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